

AD-A155 406

BLACKSTONE RIVER BASIN
GRAFTON, MASSACHUSETTS

FISHERVILLE POND DAM
MA 00577

PHASE I INSPECTION REPORT NATIONAL DAM INSPECTION PROGRAM

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This 910 ft. long is an earthfill dam with a stone masonry, narrow crested spillway. There were visible signs of seepage at the downstream toe of the dam. It has been placed in the high hazard category. It is recommended that the owner of the dam employ a qualified engineer to evaluate the stability of the dam.		

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

APR 16 1979

REPLY TO
ATTENTION OF:

NEDED-E

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts

Accession For	
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Dear Governor King:

I am forwarding for your use a copy of the Fisherville Pond Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. The report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis. A brief assessment which emphasizes the inadequacy of the project spillway under test flood conditions is included at the beginning of the report.

The preliminary hydrologic analysis has indicated that the spillway capacity for the Fisherville Pond Dam would likely be exceeded by floods greater than 22 percent of the Probable Maximum Flood (PMF), the test flood for spillway adequacy. Screening criteria for initial review of spillway adequacy specifies that this class of dam, having insufficient spillway capacity to discharge fifty (50) percent of the PMF, should be adjudged as having a seriously inadequate spillway and the dam assessed as unsafe, non-emergency, until more detailed studies prove otherwise or corrective measures are completed.

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to indicate the same degree of emergency as would be associated with "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening and preliminary computations there appears to be a serious deficiency in spillway capacity. This could render the dam unsafe in the event of a severe storm which would likely cause overtopping and possible failure of the dam, significantly increasing the hazard potential for loss of life downstream from the dam.

NEDED-E

Honorable Edward J. King

It is recommended that within twelve months from the date of this report the owner of the dam engage the services of a professional or consulting engineer to determine by more sophisticated methods and procedures the magnitude of the spillway deficiency. Based on this determination, appropriate remedial mitigating measures should be designed and completed within 24 months of this date of notification. In the interim a detailed emergency operation plan and warning system should be promptly developed. During periods of unusually heavy precipitation, round-the-clock surveillance should be provided.

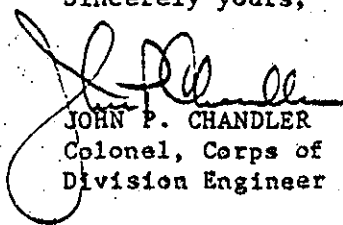
I have approved the report and support the findings and recommendations described in Section 7, with qualifications as noted above. I request that you keep me informed of the actions taken to implement these recommendations since this follow-up is an important part of the non-Federal Dam Inspection Program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. This report has also been furnished to the owner of the project, Katsas Brothers, Inc., 120 Main Street, Grafton, Massachusetts 01519.

Copies of this report will be made available to the public, upon request to this office, under the Freedom of Information Act, thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for the cooperation extended in carrying out this program.

Sincerely yours,



JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

FISHERVILLE POND DAM

MA 00577

BLACKSTONE RIVER BASIN
GRAFTON, MASSACHUSETTS

PHASE I - INSPECTION REPORT
NATIONAL DAM INSPECTION
PROGRAM

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA00577

Name of Dam: Fisherville Pond

Town: Grafton

County and State: Worcester County, Massachusetts

Stream: Blackstone River

Date of Inspection: September 20, 1978

Fisherville Pond Dam is an earthfill dam with a stone masonry, narrow crested spillway. The dam, which was constructed in about 1882, has a total length of 910 feet, including the embankment, spillway, outlet works, and diversion structure. The embankment has a maximum height of 10 feet and is approximately 650 feet long. The 200-foot long spillway is constructed of granite blocks stepped on the downstream side. There is a low level outlet structure at the east end of the spillway. There is also an abandoned gated diversion structure at the west end of the dam on the Blackstone Canal.

Fisherville Pond Dam was neither designed nor constructed according to current approved state-of-the-art procedures. Based upon the visual inspection at the site, the limited engineering data, and little evidence of operating or maintenance procedures, it was concluded that these are deficiencies that must be corrected to assure the continued performance of this dam. Generally, the dam is considered to be in fair condition. Because of the potential danger to lives and property downstream of Fisherville Pond and according to the Corps of Engineers guidelines for the classification of hazard potential, the dam has been placed in the "high" hazard category.

The following visible signs of distress indicate a potential hazard at the site: seepage at the downstream toe of the dam, lack of adequate riprap

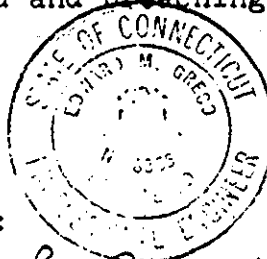
FISHERVILLE POND DAM

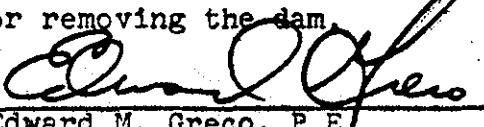
protection on the upstream face of the dam, thick vegetation and trees growing downstream of the dam, debris scattered on the dam, inoperable slide gates on the Blackstone Canal diversion structure, accumulation of debris in the inlet channel for the outlet and diversion structures, and missing or cracking mortar on the stone masonry training walls at the outlet and diversion structures.

Hydraulic analyses indicate that the spillway can discharge a flow of 13,000 cubic feet per second (cfs) at elevation (El) 296.0, which is the average elevation of the crest of the dam. The test flood (full PMF) produces an outflow of 58,800 cfs and would overtop the dam by about 8.2 feet. The spillway can discharge only 22.1 percent of the test flood before the dam is overtopped. In the event of overtopping, complete failure of the dam could occur.

It is recommended that the Owner employ a qualified consultant to evaluate the stability of the dam, evaluate the seepage at the downstream toe of the dam, and conduct a more detailed hydrologic and hydraulic investigation. It is also recommended that the Owner repair the slide gate on the outlet structure, repair gates and gate-operating mechanisms on the diversion structure, clear debris from inlet channels at both the outlet and diversion structures, add riprap to the upstream slope of the dam, remove debris from the dam, and remove all trees and brush from the dam and downstream of the toe of the dam. The Owner should also implement a systematic program of inspection and maintenance.


The above recommendations and remedial measures should be implemented by the Owner within a period of two years of receipt of this Phase I Inspection Report. An alternative to these recommendations would be draining the pond and breaching or removing the dam.




Edward M. Greco, P.E.
Project Manager
Metcalf & Eddy, Inc.

Connecticut Registration
No. 08365

Approved by:


Stephen L. Bishop, P.E.
Vice President
Metcalf & Eddy, Inc.

Massachusetts Registration
No. 19703



FISHERVILLE POND DAM

This Phase I Inspection Report on Fisherville Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Richard F. Doherty

RICHARD F. DOHERTY, MEMBER
Water Control Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph A. McElroy

JOSEPH A. MCELROY, CHAIRMAN
Chief, NED Materials Testing Lab.
Foundations & Materials Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for a Phase I Investigation. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrology and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general conditions and the downstream damage potential.

FISHERVILLE POND DAM

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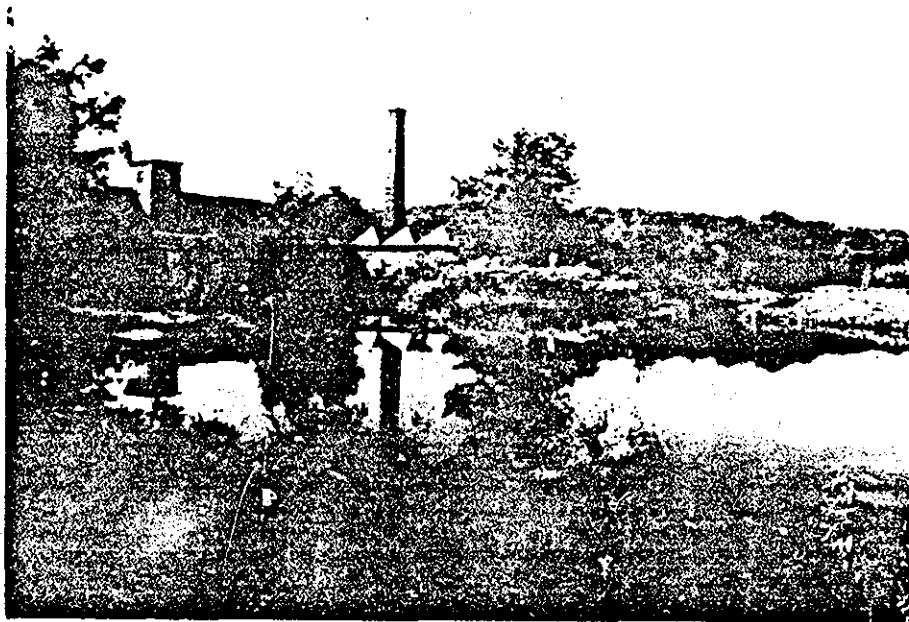
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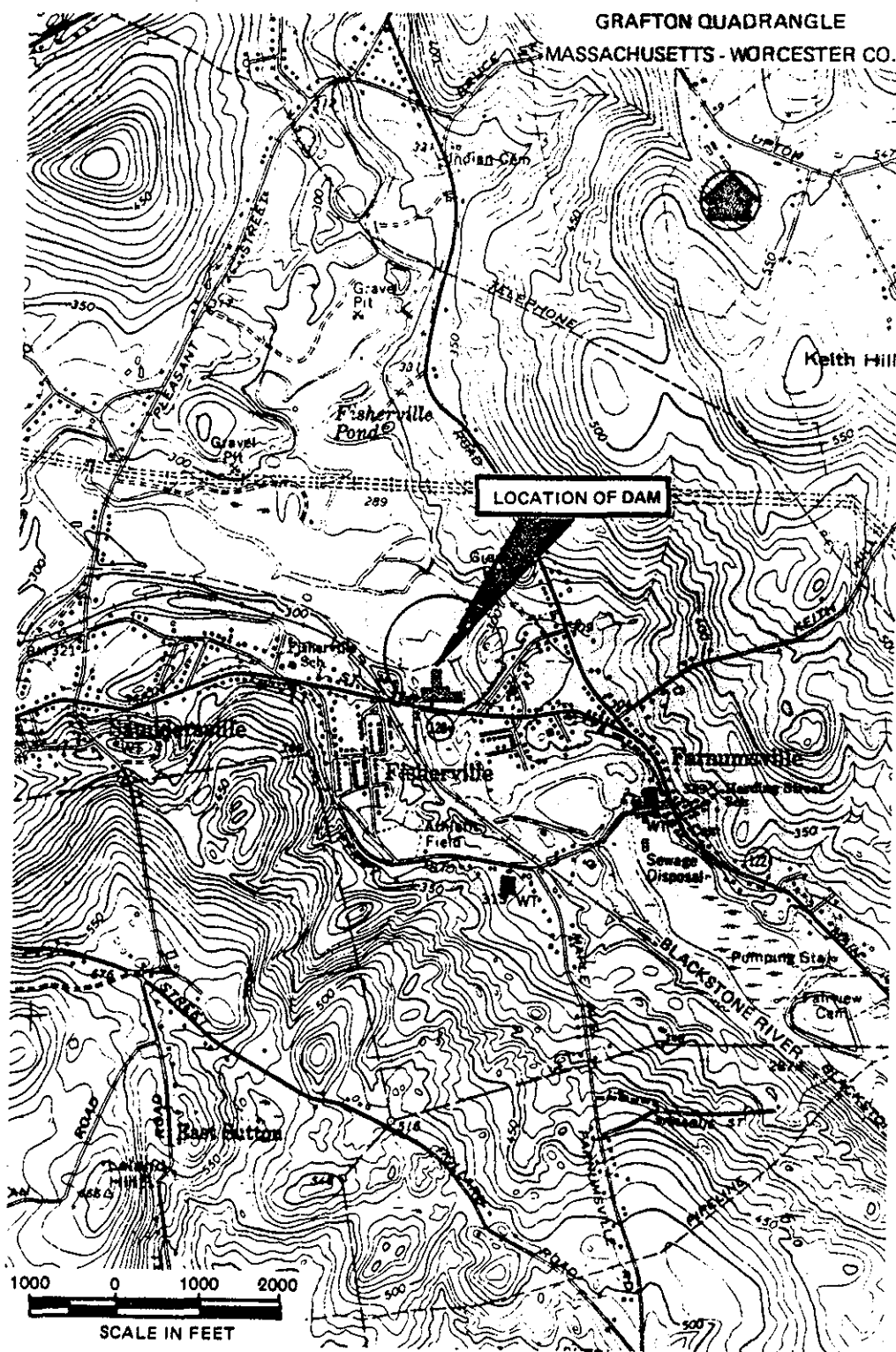
FISHERVILLE POND DAM

OVERVIEW
FISHERVILLE POND
GRAFTON, MASSACHUSETTS



VIEW OF DAM FROM UPSTREAM OF EAST ABUTMENT

Location and Direction of Photographs
Shown on Figure in Appendix B



LOCATION MAP - FISHERVILLE POND DAM

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

FISHERVILLE POND DAM

SECTION 1

PROJECT INFORMATION

1.1 General

- a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Metcalf & Eddy, Inc. under a letter of July 28, 1978, from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW 33-78-C-0306 has been assigned by the Corps of Engineers for this work.
- b. Purpose
 - (1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
 - (2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.
 - (3) Update, verify and complete the National Inventory of Dams.

FISHERVILLE POND DAM

- (3) Height: Main dam: 10 feet - maximum
- (4) Top width: Main dam: 15 feet
- (5) Side slopes: Main dam - Upstream: 1.5
to 3.6:1
Downstream: 1.5 to 2.7:1
- (6) Zoning: Unknown
- (7) Impervious core: Unknown
- (8) Cutoff: Unknown, except for a short
stone cutoff wall extending 25 feet from
west spillway wall into dam
- (9) Grout curtain: Unknown

1. Spillway

- (1) Type: Narrow-crested weir - no
flashboards
- (2) Length of weir: 200 feet
- (3) Crest elevation: 289.0
- (4) Gates: None
- (5) Upstream channel: Stone masonry, and
stone masonry wingwalls.
- (6) Downstream channel: Downstream face of
weir is stepped stone masonry. Below
this is a natural stream bed.

- j. Regulating Outlets. The low level outlet at the dam is a 6-foot by 6-foot slide gate located at the east end of the spillway. The outlet has a capacity of 300 cfs (2.2 cfs per square mile). This gate reportedly is used every spring and fall. A second outlet consists of six wooden slide gates in the Black-stone Canal diversion structure. Since the six handwheel operating mechanisms are rusted, this outlet is inoperable.

FISHERVILLE POND DAM

reservoir is open water, whereas the remainder is covered with a growth of swampy cattails and is heavily silted.

The spillway is situated near the east abutment of the dam. The spillway is a narrow-crested weir constructed of granite blocks stepped on the downstream side. There is a small bedrock outcrop on the downstream side near the east end of the spillway. The spillway is 200 feet long and about 13 feet high. There are no flashboards on the spillway. The side walls of the spillway are constructed of mortared stone and are 8.7 feet (west side) to 13.0 feet (east side) above the crest. The upstream face of the spillway is shown on drawings (see Figure B-2) as riprap or paving, sloping at 2:1 covering an earth fill.

The Blackstone Canal (see Figure B-1) is an open channel that bypasses water from the Blackstone River through the west end of the dam, underneath the factory and beneath Main Street through an arched stone bridge. Downstream of Main Street, the canal is a separate open channel that connects further downstream with the Blackstone River. A gated diversion structure is located on the canal at the west abutment of the dam. The diversion structure is 32.8 feet wide and about 16 feet high. It is covered with a concrete bridge about 10 feet wide. The entire structure is concrete except for the two side walls constructed of mortared stone. There are six handwheel operating mechanisms on the top of the bridge at the upstream side connecting to the wooden slide gates, each 7.5 by 4.5 feet in dimension. There is considerable trash and debris floating on the upstream water surface collecting on the slide gates. The west bank of the canal immediately downstream of the gate structure is covered with rock. Further downstream, in the canal, there are vertical side walls constructed of dry stone masonry which extend downstream to the factory. A footbridge and trash gate made of wooden timbers is located part way between the diversion structure and the factory. A slide gate intake is located on the outside wall of the factory.

FISHERVILLE POND DAM

The outlet structure for the dam is located at the east end of the spillway (see Figure B-1). It is about 18.6 feet high. The intake consists of two straight vertical stone masonry walls about 4.5 feet thick with mortared joints. The distance between the intake walls is 9.5 feet. The east wall extends a considerable distance downstream of the structure at the east dam abutment. The bottom 7 feet of both downstream training walls is concrete and each is 7 feet long. A concrete walkway 5.5 feet wide extends from wall to wall. A vertical concrete headwall extends from the sidewalk to the top of an opening for a 6-foot by 6-foot wooden slide gate. The headwall is partially recessed on the downstream face. One handwheel operating unit for a rack and pinion gear-raising mechanism is located on the upstream edge of the concrete walkway. The elevation of the bottom of the slide gate is 283.3, about 5.7 feet below the spillway crest. There is some leakage in the top east corner of the slide gate.

The discharge channel for the outlet structure exposes some bedrock outcrops. The channel converges downstream with the Blackstone River channel, forming a small island. The Blackstone River subsequently flows underneath the Main Street bridge located about 700 feet downstream of the dam.

- c. Size Classification. Fisherville Pond Dam is classified in the "intermediate" category since it has a maximum height of 10 feet and a maximum storage capacity of 1,360 acre-feet.
- d. Hazard Classification. Fisherville Pond is situated in an undeveloped rural area north of the Town of Fisherville in the Town of Grafton. There is a large factory immediately downstream of the dam. Some residential and small commercial buildings are situated near the east side of the Blackstone River along Main Street, less than 10 feet above the elevation of the streambed. In the event of overtopping and complete failure of the dam, more than a few lives could be lost

FISHERVILLE POND DAM

in the factory downstream of the dam and excessive property damage could occur in the factory and in the downstream areas along Main Street. Accordingly, the dam has been placed in the "high" hazard category.

- e. Ownership. The dam is presently owned by Kaltsas Brothers, Inc., 120 Main Street, Grafton, Massachusetts. 01519. Mr. James Kaltsas (telephone: 617-757-0264) granted permission to enter the property and inspect the dam. Prior to 1955 the dam was owned by Fisherville Realty Trust.
- f. Operator. The only known operators of this dam are personnel of the Duralite Co., Inc. This company leases the factory immediately downstream of the dam as well as the water rights from Kaltsas Brothers, Inc.
- g. Purpose of Dam. The earliest records in 1923 indicate the dam provided storage water for a mill at the site. The dam now serves no direct function although indirectly is used for flood control.
- h. Design and Construction History. The only plans available for this dam are dated 1882. At that time, the dam was owned by Fisher Manufacturing Co. Ownership was transferred to Fisherville Manufacturing Co. by 1945, then to Fisherville Realty Trust by 1955. Prior to 1963, the dam was the property of Prest Wheel, Inc. By 1968, ownership was transferred to Kaltsas Brothers, Inc. In 1969 ownership was shared by Kaltsas Brothers, Inc, and Prest Wheel Company. The dam is presently owned by Kaltsas Brothers, Inc.

Previous inspection reports indicate no leakage from the dam and reports from 1929 to 1967 reveal the dam was "OK". In 1935, 1945, and 1963, trees and brush on the dam embankment were reported.

The use of 12-inch high flashboards on the spillway was reported in the period of 1939 through 1942. The 1933 inspection report

FISHERVILLE POND DAM

recommended replacement of about 30 feet of the stepped stone spillway apron that had washed out. In 1945, these repairs were made. In 1955 some damage to the east end of the spillway was observed, but was not defined due to high water. The 1963 inspection report recommended patchwork on the easterly spillway abutment wall and in 1968 remortaring of both walls was recommended. The spillway and downstream channel was clogged with debris in 1963, as well as the intake channel to the outlet structure.

Fisher Manufacturing reportedly complained about flooding of the mill building immediately downstream prior to 1855. This would infer that a dam existed on the site prior to 1882. Along the Blackstone River, reservoir storage capacities were reportedly diminished by the rapid accumulation of silt in 1938, 1954 and 1955. There is no mention in the records of overtopping in 1955, although the road downstream was reportedly washed out. Flooding in March, 1968, of the first floor of the factory building is reported to be the result of water unable to flow downstream since the channel and pond bottom below the bridge on Main Street were silted up. (The canal gates were wide open.) In early March, 1969, the owner of this dam sent a letter to the owner of the O'Donnell Dam downstream requesting that the O'Donnell gates be opened to prevent flooding at the mill. In latter March, 1969, 12 inches of water were reported on the spillway crest during flooding of the basement in the mill building. An earth dike was then constructed in April, 1969, along the banks of the Blackstone River and along the mill. In May, 1969, officials from the Town, County, State and Federal government visited this site as part of a proposed flood control project. In a 1969 letter to the Honorable Congressman Harold D. Donahue, a commission made a number of recommendations for flood control including dredging of Fisherville Pond, Farumsville Pond (downstream) and the river from the dam down to the Main Street Bridge, and increasing the bridge span. (The bridge construction, which

FISHERVILLE POND DAM

was completed in 1957, has a clear span of 82 feet.) However, further flooding in the mill was still reported in February, 1970.

A drawing dated 1882 indicated gates on the canal and a new bridge over the canal. In 1922, some cement foundation repairs were made to the canal head gates. An inspection report dated 1963 states that the canal gates were in fair condition and the channel was clogged with debris. According to an inspection report dated 1968, the canal gates were beginning to deteriorate and again the inlet was blocked with debris. A log boom across the gates was recommended to prevent trash accumulation in the gates.

1. Normal Operational Procedures. The outlet gate just east of the spillway is reportedly operable. It is reportedly used every spring and fall to regulate water level to avoid flooding at the mill. The spillway is ungated and has no flashboards.

The six slide gates at the Blackstone Canal diversion structure are inoperable.

1.3 Pertinent Data

- a. Drainage Area. The drainage area for Fisherville Pond is approximately 85,760 acres (134 square miles). It consists of mostly hilly woodland areas with limited agricultural development, and a large number of towns and cities.
- b. Discharge at the Dam Site. Uncontrolled discharge at the dam site flows over the 200-foot long granite stone narrow-crested weir at the east end of the dam into the Blackstone River stream channel. The channel is approximately 220 feet wide at the downstream edge of the spillway, including the outlet channel. The downstream spillway surface is stepped stone masonry except for a bedrock outcrop on the east end of the spillway. There is an island just downstream of this bedrock outcrop. The river channel is relatively clear except for a few overhanging trees and bushes and on the east

FISHERVILLE POND DAM

side some stone and other debris. The river channel flows underneath a bridge on Main Street about 700 feet downstream of the dam. There has been some minor erosion of the man-made dike along the west bank of the main river channel.

Hydraulic analyses indicate that the spillway can discharge 13,000 cfs at about El 296.0 which is the average elevation of the crest of the dam.

An inflow test flood of 60,000 cfs (the full probable maximum flood) adjusted for surcharge storage results in a maximum discharge of 58,800 cfs. This outflow will overtop the dam by 8.2 feet. There are no records of dam overtopping. However, flooding of the mill immediately downstream of the dam was reported in 1968, 1969 and 1970.

Controlled discharge was formerly through the Blackstone Canal diversion structure slide gates which are closed and no longer operable.

- c. Elevation (feet above Mean Sea Level (MSL)).
A benchmark of 289 on the crest of the spillway was estimated from a U.S. Geological Survey topographic map.

- (1) Top dam: Main Dam: 295.6 to 300.0
- (2) Test flood pool: 304.2
- (3) Design surcharge (original design):
Unknown
- (4) Full flood control pool: Not applicable
(N/A)
- (5) Recreation pool: N/A
- (6) Spillway crest: 289.0
- (7) Upstream portal invert diversion tunnel:
N/A

FISHERVILLE POND DAM

(8) Stream bed at dam (outlet channel):
283.0

(9) Maximum tailwater: 280.3

d. Reservoir

(1) Length of maximum pool: 4,000 feet

(2) Length of recreation pool: N/A

(3) Length of flood control pool: N/A

e. Storage (acre-feet)

(1) Test flood surcharge (net): 2,800 at
El 304.2

(2) Top of dam: 1,360

(3) Flood control pool: N/A

(4) Recreation pool: N/A

(5) Spillway crest: 250

f. Reservoir Surface (acres)

*(1) Top dam: 185

*(2) Maximum pool: 185

(3) Flood-control pool: N/A

(4) Recreation pool: 185

(5) Spillway crest: 185

g. Dam

(1) Type: Main dam: earthfill

(2) Length: Main dam: 650 feet

*Based on the assumption that the surface area will
not significantly increase with changes in reservoir
elevation from 289 to 304.2

FISHERVILLE POND DAM

- (3) Height: Main dam: 10 feet - maximum
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this is a natural stream bed.

- j. Regulating Outlets. The low level outlet at the dam is a 6-foot by 6-foot slide gate located at the east end of the spillway. The outlet has a capacity of 300 cfs (2.2 cfs per square mile). This gate reportedly is used every spring and fall. A second outlet consists of six wooden slide gates in the Blackstone Canal diversion structure. Since the six handwheel operating mechanisms are rusted, this outlet is inoperable.

FISHERVILLE POND DAM

SECTION 2
ENGINEERING DATA

- 2.1 General. The only plans available for Fisherville Pond Dam are 1882 plans of the spillway, dam and canal. There are no specifications or computations available from the Owner, State, or County offices, relative to the design and construction of the dam. The remaining data available for this evaluation were visual observations made during inspection, review of previous inspection reports, and conversations with the Owner, the mill occupant, State and County personnel.

We acknowledge the assistance and cooperation of personnel of the Massachusetts Department of Public Works: Messrs. Willis Regan and Raymond Rochford, and of the Massachusetts Department of Environmental Quality Engineering, Division of Waterways: Messrs. John J. Hannon and Joseph Iagallo.

Also, we acknowledge the cooperation and assistance of personnel from the Worcester County Engineer's Office: Messrs. John O'Toole, Joseph Brazauskas, and Mr. Wallace Lindquist - recently retired from county service.

Mr. James Kaltsas granted permission to enter the property and inspect the dam.

- 2.2 Construction Records. There are no construction records available.
- 2.3 Operating Records. No operating records are available for the dam and no daily record is kept of the elevation of the pool or rainfall at the dam site.
- 2.4 Evaluation
- a. Availability. Due to the age of this dam, there is limited engineering data available.
 - b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore the adequacy of this dam could not

FISHERVILLE POND DAM

be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and engineering judgment.

- c. Validity. The limited engineering data available is valid for this assessment.

FISHERVILLE POND DAM

SECTION 3
VISUAL INSPECTION

3.1 Findings

- a. General. The Phase I inspection of the dam at Fisherville Pond was performed on September 20, 1978. A copy of the inspection checklist is included in Appendix A. Previous inspections of this dam have been made by others since 1929. A partial listing of these inspections is in Appendix B.
- b. Dam. In general, the dam is in fair condition. A narrow pool of dark stagnant water about 130 feet long at the downstream toe of the dam extends into a downstream semi-swamp area and indicates seepage through or underneath the dam. Surface runoff from the crest appears to be eroding the upstream and downstream faces, particularly, near the west training wall of the spillway. The west half of the downstream face is partially eroded. Both slopes and the crest are covered with brush, trees and scattered debris, including a wood platform and telephone pole. In addition, a large animal burrow about 1 foot in diameter and at least 3 feet deep was observed. There is no riprap protection on the upstream slope except for a few pieces of stone just west of the spillway.
- c. Appurtenant Structures. The stonework of the spillway is in good to fair condition. Some of the mortar of the spillway sidewalls is missing or has cracked. At the time of inspection, water was flowing over the spillway. The east spillway stone sidewall which also serves as the west outlet sidewall, was covered with a growth of vines and brush. The main downstream channel is relatively clear of debris and vegetation. There are a few overhanging trees on the east side channel. There has been some minor erosion of the man-made dike along the west bank of the main river channel.

FISHERVILLE POND DAM

The outlet structure at the east end of the spillway is in fair condition. The inlet which was not completely visible was clogged with floating debris. The inlet to the gate structure is two mortared masonry stone walls. There is leakage from the upper east corner of the deteriorated slide gate. The wooden slide gate is 6 feet by 6 feet and is raised by a wheel connected to a rack and pinion raising mechanism. The gate is reportedly operated every fall and spring to regulate water level to avoid flooding at the mill. The outlet from the gate structure is two mortared masonry stone walls with the lower portions concreted. Some of the mortar of the inlet and outlet walls is missing or has cracked. There is no spalling of concrete in the outlet walls and headwall. There are some bedrock outcrops in the downstream channel. The channel is relatively clear except for a few overhanging trees and bushes and also some stone and other debris.

The second outlet which is a diversion structure on the right abutment on the Blackstone Canal is in poor condition. The entire structure including the bridge is concrete, except for the mortared masonry side walls. The concrete is in fair condition with minor cracking, except below a high water mark where the concrete is spalled. Some of the mortar of the outlet sidewalls is missing or has cracked. The six wooden slide gates are inoperable due to debris clogging the upstream face and six rusty deteriorating hand wheel mechanisms. There is severe leakage through the gates. Two of the six units are inaccessible due to the fence on the bridge. The approach channel is flat and contains silt and debris. The immediate downstream channel is relatively clear except for a few rocks on the west bank.

- d. Reservoir Area. Fisherville Pond is situated in mostly an undeveloped flat to hilly rural area north of the Town of Fisherville. A high tension power line crosses the pond north of the dam about 2,000 feet. The Quinsigamond River flows into the north end of the pond and the Blackstone River into the

FISHERVILLE POND DAM

west end of the pond. There is considerable meandering of the Quinsigamond River in the pond which is mostly covered with a heavy growth of cattails.

- e. Downstream Channel. The discharge from the spillway flows down the Blackstone River. About 700 feet downstream of the dam, the river crosses under a bridge on Main Street. About 700 feet downstream of the bridge, the Blackstone Canal joins the Blackstone River.

- 3.2 Evaluation. The above findings indicate that the dam has several areas of distress that require attention. It is evident that the dam is not adequately maintained and that deterioration will continue unless action is taken. Recommended measures to improve these conditions are included in Section 7.

SECTION 4

OPERATING PROCEDURES

- 4.1 Procedures. There are no formal operating procedures at Fisherville Pond Dam.
- 4.2 Maintenance of Dam. There is no systematic maintenance program at the dam.
- 4.3 Maintenance of Operating Facilities. The outlet gate is generally closed although it is reportedly opened every spring and fall. Flow over the spillway is uncontrolled. The six outlet gates on the Blackstone Canal diversion are inoperable.
- 4.4 Description of Any Warning System in Effect. There is no warning system in effect at this dam.
- 4.5 Evaluation Fisherville Pond Dam is in fair condition and has been placed in the "high" hazard category because of the possible danger to life and property downstream. For this reason, it is important that procedures for operation, maintenance and emergencies be implemented as recommended in Section 7.

FISHERVILLE POND DAM

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

- a. Design Data. The probable maximum flood (PMF) rate was determined to be 450 cfs per square mile. This calculation is based on an average drainage area slope of 0.9 percent, the pond-plus-swamp area to drainage area ratio of 5.1 percent, and the U.S. Army Corps of Engineers' Flow Rates (dated December 1977). Applying the full PMF rate to the 134 square miles of drainage area results in a calculated peak flood flow of 60,000 cfs as the inflow test flood. By adjusting the inflow test flood for surcharge storage, the maximum discharge rate was established as 58,800 cfs (439 cfs per square mile) with the water surface at El 304.2. Flow over the crest of the dam is predicted to be 17,800 cfs, and flow through the spillway would be 41,000 cfs. The maximum head on the dam would be 8.2 feet with a discharge of 59.87 cfs per foot of width. Depth at critical flow would be 4.80 feet with a velocity of 12.50 feet per second.

Hydraulic analyses indicate that the spillway can discharge an estimated 13,000 cfs when the water surface is at El 296.0, which is the average elevation of the crest of the dam. The spillway can discharge only 22.1 percent of the test outflow before the dam is overtopped.

- b. Experience Data. Hydraulic records are not available for this dam. There is no documentation of overtopping of this dam.

U.S. Geological Survey water resources data for the Blackstone River Gaging Station downstream of the dam were reviewed. Although extreme discharges were recorded, their effects on the dam were not significant.

- c. Visual Observations. Discharge from Fisherville Pond is over the spillway located on

FISHERVILLE POND DAM

the east end of the dam. The spillway is a 200-foot long narrow-crested weir.

The stepped stone masonry spillway is in good to fair condition; some of the mortar on the two sidewalls is cracked or missing. The east end of the spillway is 0.1 foot lower than the west end. At the time of the inspection, the water level in the reservoir was almost 0.2 feet above the crest of the spillway. Therefore, most of the spillway was not visible.

- d. Overtopping Potential. Overtopping of the dam by about 8.2 feet is expected under the test flood outflow of 58,800 cfs. In the event of overtopping, complete failure of the dam and spillway could occur.

Failure of the dam only would produce a peak discharge of 7,000 cfs and, combined with the spillway discharge of 13,000 cfs, results in a total peak flow of 20,000 cfs. The depth of flow in the stream channel downstream of the dam prior to dam failure would be about 7.1 feet. Subsequent to dam failure, the depth of flow would increase 1.9 feet for a total depth of 9 feet. The impact of the dam failure on downstream properties along Main Street would be increased flooding and additional property damage. The most severe impact of dam failure would be on the factory buildings immediately downstream of the dam. The failure wave could severely damage buildings and cause the loss of many lives depending on where the break occurred.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

- a. Visual Observations. The evaluation of the structural stability of the dam is based on the visual inspection conducted on September 20, 1978. As discussed in Section 3, Visual Inspection, the dam appears to be in fair condition. It is recommended that a more detailed investigation be initiated to evaluate the stability of the dam and spillway and the seepage at the downstream toe of the dam.
- b. Design and Construction Data. There is one plan (Figure B-2) available for this dam. This plan shows a homogeneous dam with a short cutoff stone wall extending 25 feet into the dam from the west spillway training wall. Information on the type, shear strength, and permeability of the soil and/or rock materials is nonexistent.
- c. Operating Records. With the exception of two plugged and inoperable observation wells, one located on the crest of the dam and the other near the downstream toe, there is no evidence that instrumentation of any type was ever installed in Fisherville Pond Dam. The performance of the spillway and dam under prior loading can only be inferred from physical evidence at the site.
- d. Post-Construction Changes. The only recorded changes after 1882 were repairs undertaken by the Owner in 1945. At that time, washed-out portions of the stepped stone spillway were replaced. However Figure B-2 shows two 4-foot by 6-foot slide gates as the outlet in the east abutment. At the present time, there is one 6-foot by 6-foot slide gate.
- e. Seismic Stability. The dam is located in Seismic Zone No. 2 and in accordance with Phase I "Recommended Guidelines" does not warrant seismic analyses.

FISHERVILLE POND DAM

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

- a. Condition. Built in 1882, Fisherville Pond Dam was neither designed nor constructed according to current approved state-of-the-art procedures. Based on the visual inspection of the site, the limited engineering data, and no evidence of operation or maintenance, there are areas of concern which must be corrected to assure the continued performance of this dam. Generally, the dam is considered to be in fair condition. The principal areas of concern are: seepage at the downstream toe of the dam; lack of adequate riprap protection on the upstream face of the dam; erosion caused by surface runoff at the downstream slope and next to the west spillway training wall; thick vegetation and brush on the upstream and downstream slopes of the dam.

Hydraulic analyses indicate that the existing spillway without flashboards can discharge a flow of 13,000 cfs when the water level in the pond is at El 296.0, which is the average elevation of the crest of the dam. The spillway can discharge only 22.1 percent of the test flood before the dam is overtopped. An outflow test flood of 58,800 cfs will overtop the dam by 8.2 feet.

The limited information available indicates flooding of the mill occurred prior to 1855 and in 1968, 1969 and 1970.

- b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and engineering judgment.

FISHERVILLE POND DAM

c. Urgency. The recommendations and remedial measures outlined below should be implemented by the Owner within two years after receipt of this Phase I Inspection Report.

d. Need for Additional Investigations. Additional investigations to further assess the adequacy of the dam and spillway are outlined below in Section 7.2, Recommendations.

7.2 Recommendations. In view of the concerns over the continued performance of the dam and spillway, it is recommended that the Owner employ a qualified consultant to:

- a. evaluate the stability of the dam
- b. evaluate the seepage at the downstream toe of the dam
- c. conduct a more detailed hydrologic and hydraulic investigation of the site to design an adequate spillway and/or to increase the storage/discharge facilities at the site. The study should include the effect of downstream conditions.

The recommendations on repairs and maintenance procedures are outlined below under Section 7.3, Remedial Measures.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The dam is not adequately maintained. It is recommended that the Owner accomplish the following:

- (1) repair the slide gate at the outlet structure to prevent leakage and deterioration
- (2) remove the debris clogging the inlet channels for the outlet, and provide a log boom and/or trash rack
- (3) add riprap on the upstream face of the dam

FISHERVILLE POND DAM

- (4) remove all debris, trees and brush from the crest, upstream and downstream face of the dam
- (5) fill in the animal burrows on the crest
- (6) remove all trees and brush downstream of the dam to expose the seepage area, and remove the scattered piles of debris in the downstream area
- (7) clear all debris from the outlet channel
- (8) repair the cracked or missing mortar on the spillway and outlet training walls
- (9) remove all brush and vegetation from the spillway east training wall
- (10) fill in the eroded slope of the dam adjacent to the west training wall of the spillway
- (11) institute a definite plan for surveillance and a warning system during periods of unusually heavy rains and/or runoff. The warning system should be coordinated with upstream reservoirs in the watershed, because flooding or failure of the upper dams will have a severe effect on Fisherville Pond
- (12) implement a systematic program of maintenance inspections. As a minimum, the inspection program should consist of a monthly inspection of the dam and appurtenances and be supplemented by additional inspections during and after severe storms. All repairs and maintenance should be undertaken in compliance with all applicable State regulations
- (13) technical inspections of this dam should be conducted on an annual basis.

7.4 Alternatives. An alternative to implementing the recommendations and the maintenance procedures itemized above would be draining the pond and breaching or removing the dam.

FISHERVILLE POND DAM

APPENDIX A
PERIODIC INSPECTION
CHECKLIST

FISHERVILLE POND DAM

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT Fisherville Pond

DATE Sept. 20, 1978

TIME 8:00 A.M.

WEATHER Clear, 70° F
280.3

W.S. ELEV. 289.1 U.S. / D.M.S.
Assumed benchmark Elevation
289, crest of spillway

PARTY:

- | | |
|-------------------------|------------------------|
| 1. <u>Edward Greco</u> | 6. <u>Warren Diesl</u> |
| 2. <u>Carol Sweet</u> | 7. _____ |
| 3. <u>Lyle Branagan</u> | 8. _____ |
| 4. <u>David Cole</u> | 9. _____ |
| 5. <u>Frank Sviokla</u> | 10. _____ |

PROJECT FEATURE	INSPECTED BY	REMARKS
1. <u>Dam</u>	<u>Edward Greco</u>	
2. <u>Spillway</u>	<u>Lyle Branagan</u>	
3. _____		
4. _____		
5. _____		
6. _____		
7. _____		
8. _____		
9. _____		
10. _____		

PERIODIC INSPECTION CHECK LIST

PROJECT Fisherville PondDATE September 20, 1978PROJECT FEATURE Dam EmbankmentNAME Edward GrecoDISCIPLINE GeotechnicalNAME Carol Sweet

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	Earth Dam - Footpath on crest changes to dirt road in rt. abut. area - Fence on top of D/S-Face
Crest Elevation	
Current Pool Elevation	289.1
Maximum Impoundment to Date	Unknown
Surface Cracks	Heavy vegetation on U/S & D/S slopes
Pavement Condition	N/A
Movement or Settlement of Crest	Irregular Crest
Lateral Movement	None visible. Heavy Vegetation.
Vertical Alignment	Relatively flat
Horizontal Alignment	Relatively straight - Bends in right abutment
Condition at Abutment and at Concrete Structures	Left abutment ties into spillway Right abutment is intake structure
Indications of Movement of Structural Items on Slopes	Bldg. near D/S toe - 200' West of spillway
Trespassing on Slopes	Debris, Large animal hole - 1' dia. & 3' deep on main dam
Sloughing or Erosion of Slopes or Abutments	Erosion on U/S & D/S
Rock Slope Protection - Riprap Failures	None visible.
Unusual Movement or Cracking at or near Toes	None visible.
Unusual Embankment or Downstream Seepage	40' to 170' West of spillway @ D/S toe water ponding
Piping or Boils	None visible.
Foundation Drainage Features	None visible.
Toe Drains	None visible.
Instrumentation System	2 - Obs. Wells

PERIODIC INSPECTION CHECK LIST

PP 1007 Fisherville Pond
 Diversion Structure
 PROJECT FEATURE to Mill - Blackstone
 Canal
 DISCIPLINE Geotechnical

DATE September 23, 1978
 NAME Edward Greco
 NAME Carol Sweet

AREA EVALUATED	CONDITION
<u>INLET WORKS - INTAKE CHANNEL AND</u> <u>INTAKE STRUCTURE</u> a. Approach Channel	Natural Earth Channel - Stone Training Walls - Diversion Canal
Slope Conditions	Flat - Silted Up
Bottom Conditions	Silt - Heavy Debris
Rock Slides or Falls	None
Log Boom	None
Debris	Heavy Accumulation
Condition of Concrete Lining	None
Drains or Weep Holes	None
b. Intake Structure	Road over gates. Conc. Structure- 6 wooden slide gates - Hand wheel operated.
Condition of Concrete - Cracked	- Fair - Minor Erosion
Stop Logs and Slots	Slide Gates -

Severe leakage through slide gates - heavy accumulation of
 debris at inlet & outlet of slide gates. Gates are
 inoperable - Rusted - debris accumulated on U/S face of gates

c. Downstream Channel - Earth Channel

1. Rock fill on west slope.
2. Channel to Stone Walled Channel - with walkway & wooden trash gate. Thereafter to gate under building.

PERIODIC INSPECTION CHECK LIST

PROJECT Fisherville Pond

DATE September 20, 1978

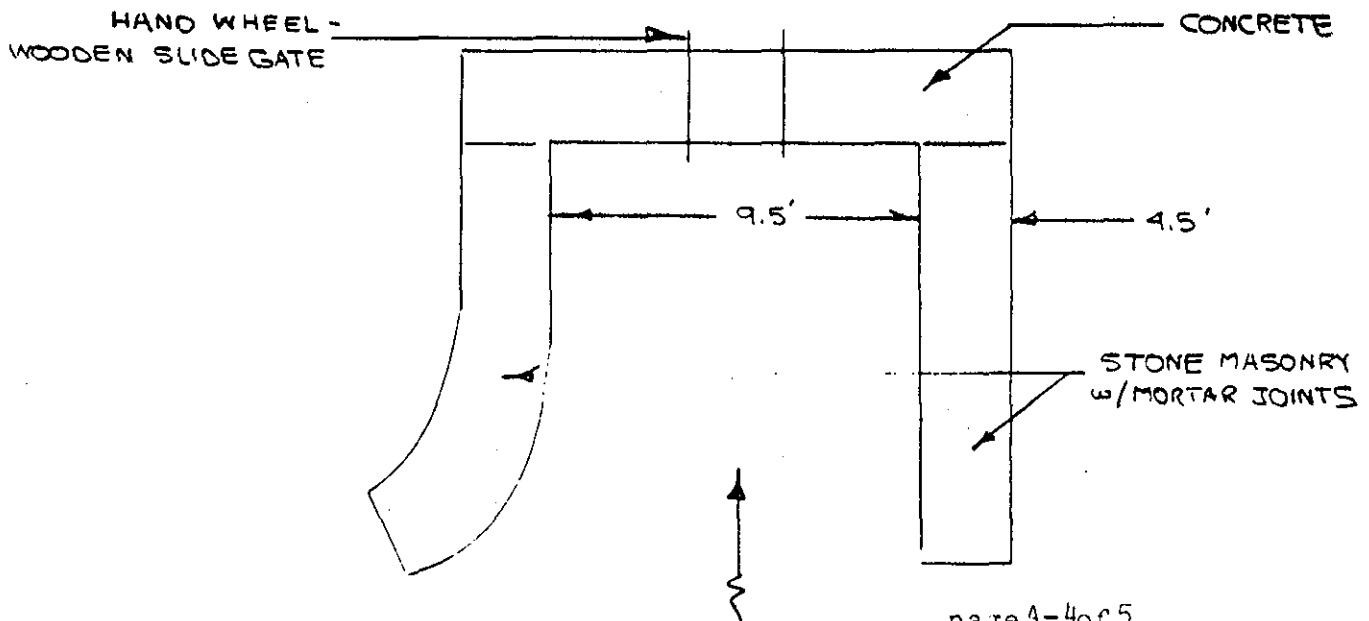
PROJECT FEATURE Outlet

NAME Edward Greco

DISCIPLINE Geotechnical

NAME Carol Sweet

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL</u>	
General Condition of Concrete	Good to fair
Rust or Staining	Slide Gate Mechanism
Spalling	None
Erosion or Cavitation	Minor
Visible Reinforcing	None
Any Seepage or Efflorescence	None - except through wooden slide gate
Condition at Joints	Good
Drain Holes	None
Channel	Bedrock Outcrops in D/S Channel
Loose Rock or Trees Overhanging Channel	Small trees
Condition of Discharge Channel	Rock & Stone Accumulation - Fair - Some debris



PERIODIC INSPECTION CHECK LIST

PROJECT Fisherville Pond

DATE September 20, 1978

PROJECT FEATURE Spillway

NAME Edward Greco

DISCIPLINE Geotechnical

NAME Carol Sweet

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	200' - Long Broad Crested Weir - Stepped Cascade - Granite Blocks
a. Approach Channel	Natural Channel - 2 Stone Masonry Walls - Mortared
General Condition	Good to fair
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Silt - Vegetation
b. Weir and Training Walls	Granite blocks - Rock outcrop in spillway - 50' from left abutment
General Condition of Concrete	Good
Rust or Staining	N/A
Spalling	N/A
Any Visible Reinforcing	N/A
Any Seepage or Efflorescence	None Visible
Drain Holes	None Visible
c. Discharge Channel	Natural Stream Bed - Blackstone River - Wide Channel
General Condition	Good to Fair
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Along Stream Bank
Floor of Channel	Natural
Other Obstructions	Bridge Downstream - 1957

Earth Dike along right side of channel build by C.E. - 1964 -
Extends from spillway to bridge - sand and gravel - Little
vegetative cover - slight erosion

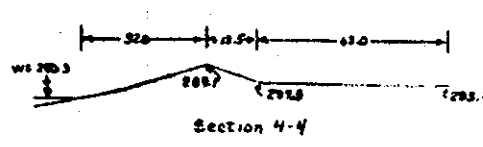
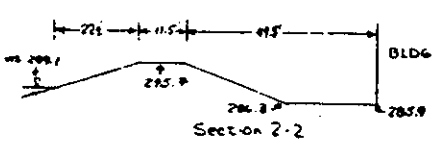
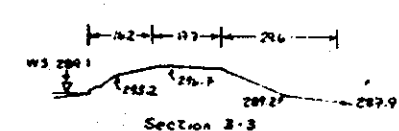
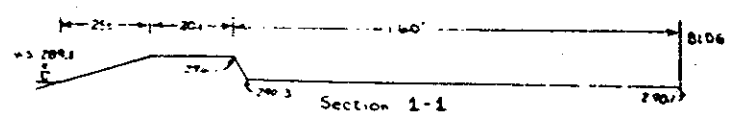
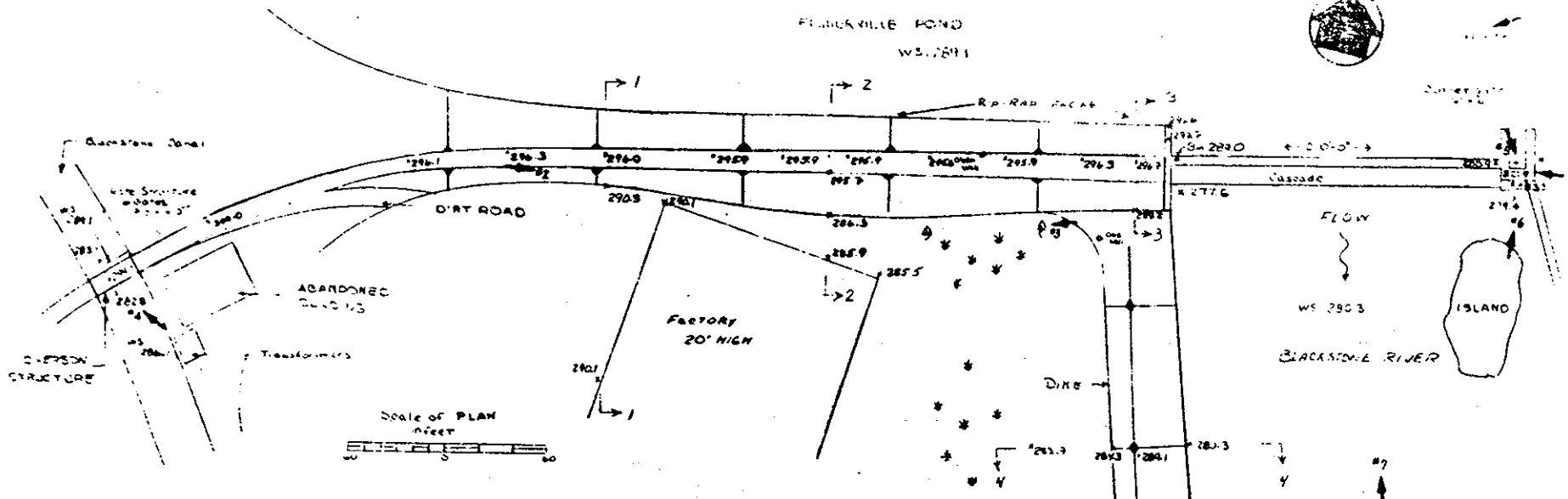
APPENDIX B

PLAN OF DAM AND PREVIOUS
INSPECTION REPORTS

	<u>Page</u>
Figure B-1, Plan of Dam and Sections	B-1
Figure B-2, Plan of Dam dated 1882	B-2
Previous Inspections (partial listing)	B-3

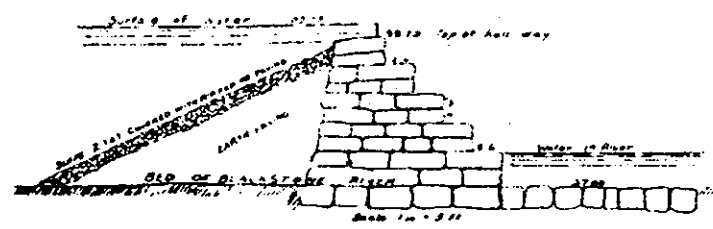
FISHERVILLE POND DAM

FISHERVILLE POND WS 2891



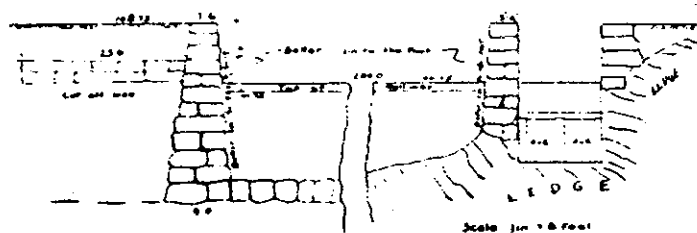
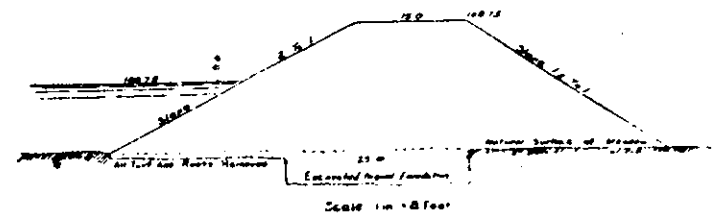
- NOTES:
- 1) Elevations shown based on assumed benchmark on Spillway Crest, E.L. 289.0 (M.S.L.)
 - 2) Information shown from field survey of Sept. 20, 1998
 - 3) A denotes seepage
 - 4) * denotes marshy land
 - 5) Plan of Dam and Sections are of different scales, 1"=60' and 1"=30' respectively

REGION 1	STATE 1	FEDERAL PROJECT NO. 1
NATIONAL PROGRAM OF INSPECTION OF DAMS		
FISHERVILLE POND DAM		
FIGURE D-1 PLAN OF DAM AND SECTIONS		
BLACKSTONE RIVER	MASSACHUSETTS	
SCALE: AS SHOWN	DATE: NOVEMBER, 1993	



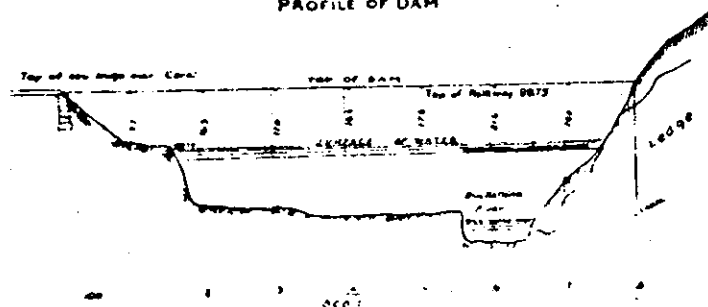
CROSS SECTION OF STONE WORK AT ROLL WAY

SECTION OF EARTH DAM



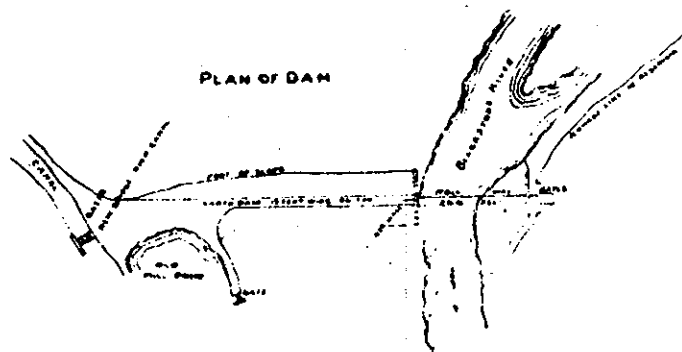
Section of Stone Walls of Roll Way and Waste Canal

PROFILE OF DAM



SCALES
HORIZONTAL 1 inch = 100 feet
VERTICAL 1 inch = 8 feet
DAM NO. 18-02

PLAN OF DAM



SCALE 1 inch = 100 feet

ENGINEER

NOTE DRAWING REDUCED FOR THIS REPORT

WORCESTER COUNTY COMMISSIONERS WORCESTER COUNTY ENGINEERING DEPARTMENT PLAN OF FISHERVILLE POND DAM GRAFTON, MASS FOR FISHER WPS CO AS FILED AND APPROVED BY THE COUNTY COMMISSIONERS JULY MEETING SCALE AS NOTED	
TRACED BY	207
FRANCIS CHECKED BY	21
APPROVED JULY 1892 BY	
DAM NO 18-02	

FIGURE 8-1

TOWN OR CITY **GRAFTON**

LOCATION **Fisherville Pond Dam - Stone Spillway.**

FISHERVILLE POND (M)
DECREE NO. **MILL POND** PLAN NO.

DAM NO. **110-18-02**

C. C. DOCKET NO.

DESCRIPTION OF DAM

Type
Length
Height
Thickness top
" bottom
Downstream Slope
Upstream "
Length of Spillway
Size of Gates
Location of Gates
Flashboards used **NONE**
Width Flashboards or Gates
Dam designed by
" constructed by
Year constructed

GENERAL REMARKS

For Fishervi Mfg Co: Grafton.

S.C. Heald, C.E. Worcester
Approved: July 11, 1882.
OWNER KALTSAS BROS, INC
120 MAIN ST, GRAFTON
" PREST. WHEEL, INC ?

DESCRIPTION OF RESERVOIR & WATERSHED

Name of Main Stream **Blackstone River**
" " any other Streams
Length of Watershed
Width " "
Is Watershed Cultivated
Percent in Forests
Steepness of Slope
Kind of Soil
No. of Acres in Watershed
" " " " Reservoir
Length of Reservoir
Width " "
Max Flow Cu. Ft per Sec.
Head or Flashboards-Low Water
" " " " High "

GENERAL REMARKS

INSPECTED 12/28/71 - PACIELLO & NICHOLSON

PREVIOUS INSPECTIONS (PARTIAL LISTING)

COPY OF INSPECTION CARD ON FILE AT THE MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS, DISTRICT OFFICE, WORCESTER.

APPENDIX C
PHOTOGRAPHS

FISHERVILLE POND DAM



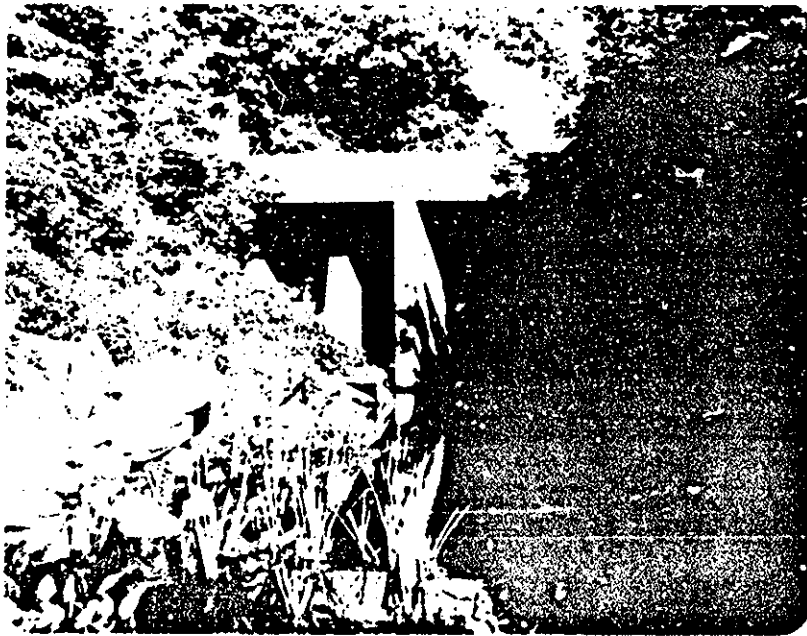
NO. 1 VIEW OF SPILLWAY



NO. 2 VIEW OF DOWNSTREAM FACE OF DAM



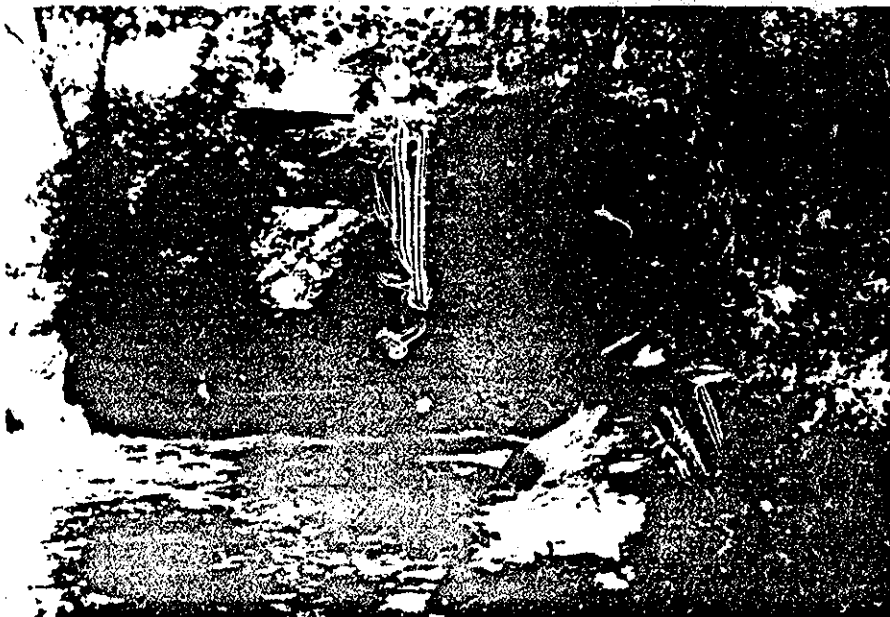
NO. 3 VIEW OF SEEPAGE AT TOE OF DAM



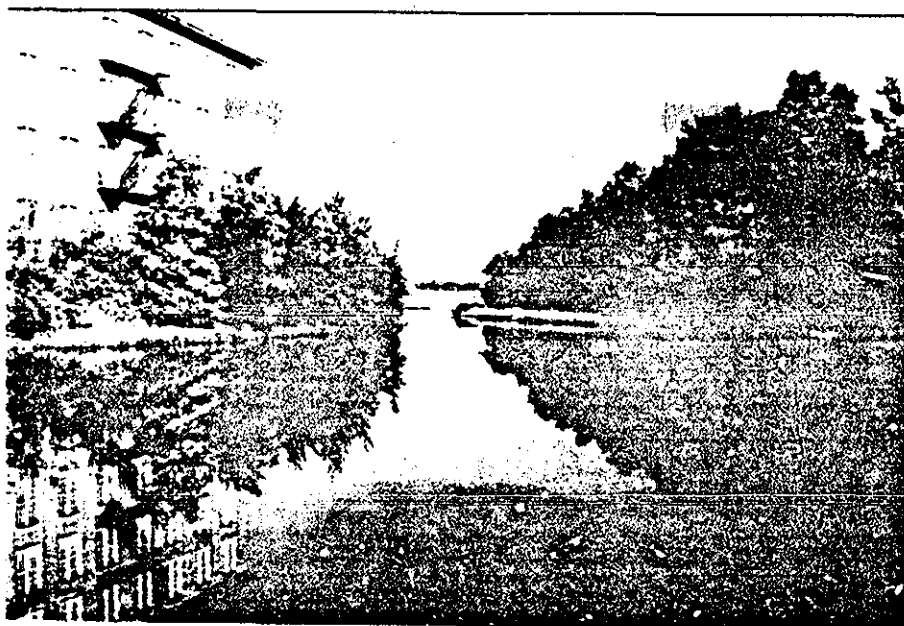
**NO. 4 VIEW OF DOWNSTREAM FACE OF ABANDONED
DIVERSION STRUCTURE**



**NO. 5 VIEW OF HEADWALL AND OPERATING
MECHANISM OF OUTLET WORKS**



NO. 6 VIEW OF DOWNSTREAM FACE OF OUTLET WORKS



**NO. 7 VIEW OF BLACKSTONE RIVER
DOWNSTREAM OF SPILLWAY**



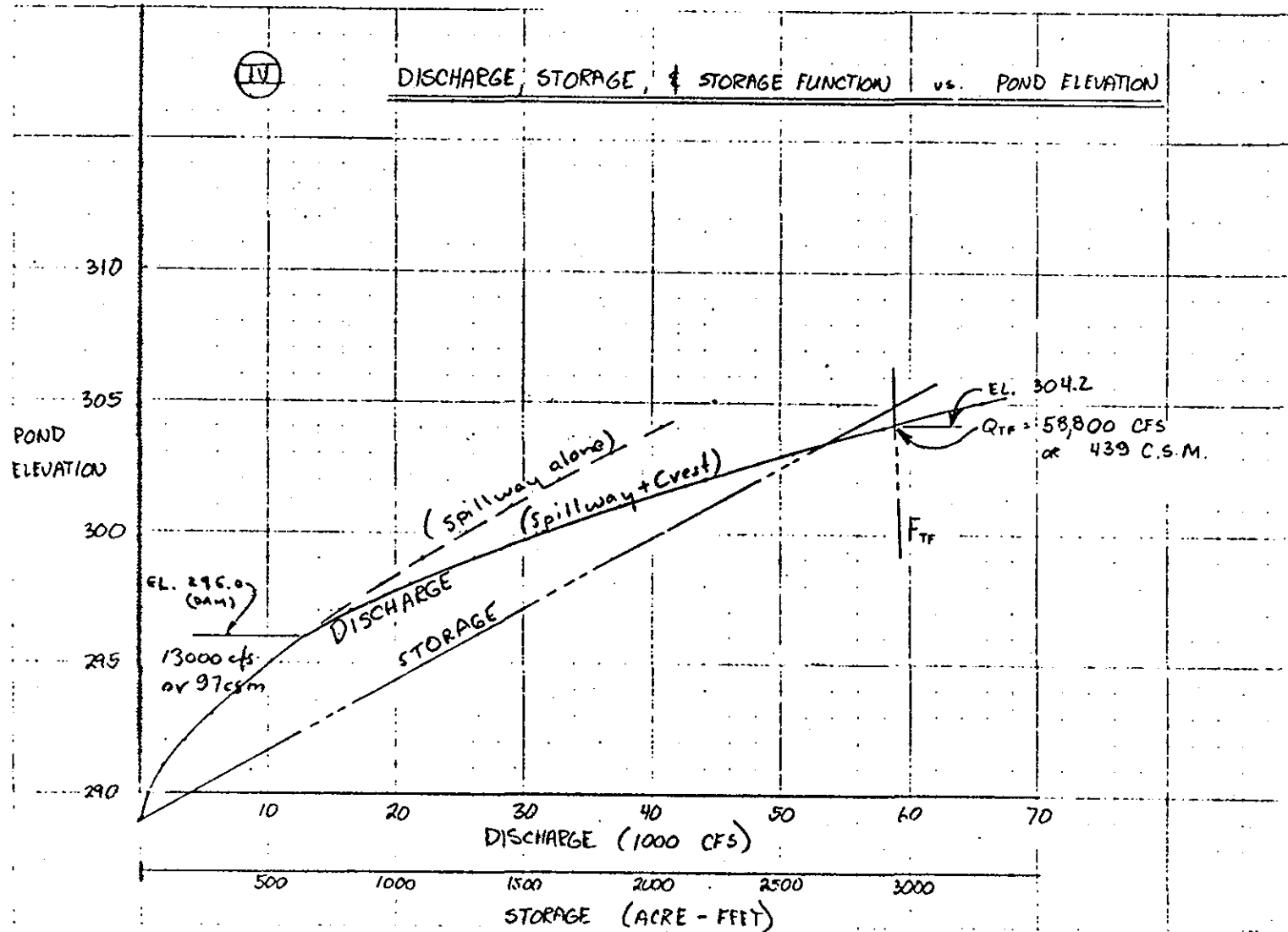
**NO. 8 VIEW OF MAIN STREET BRIDGE
OVER BLACKSTONE RIVER**

APPENDIX D
HYDROLOGIC AND HYDRAULIC
COMPUTATIONS

FISHERVILLE POND DAM

METCALF & EDDY, ENGINEERS

D-4



Project: WAT. RESER. AT N.W. 113 CROSS Acct No: 3031 Page: 4 of 6
 Subject: WATER RES. MASS. RFR Compd By: W.F. DUNN / L.G. Date: 11-17-82
 Detail: FISHKILL POND DAM Ckd By: M.L. / H.B.G. Date: 12/2/82

III

DAM DRAWDOWN RATINGS (CONT.)

A) GATE ON SIDE OF SPILLWAY -

6'W x 6'D, INV = 283.3

REF AS CULVERT N' WET CONT. (REF CROW, p-28)

H/D	1.0	1.25	1.5	2.0	3.0	4.0
Q_6 (cfs)	270	354	420	510	720	810
POND ELEV	289.3	290.8	292.3	295.3	301.3	307.3

B) GATES IN BLACKSTONE CANAL

6 @ 4.5'W x 7.5'D INV = 283.1

H/D	1.0	1.25	1.5	2.0	3.0
Q_6 (cfs)	1755	2295	2700	3375	4320
POND ELEV	290.6	292.5	294.4	298.1	305.6

C) TIME TO LOWER POND ONE FOOT WHEN AT ELEVATION 290
USING GATE ON SIDE OF SPILLWAY (ASSUME $Q_{INT} \approx 300$ cfs)

$$T = \frac{185 (43560)}{300 (60)} = 448 \text{ MIN} = 7.46 \text{ HRS}$$

Project NAT REVIEW OF NON FED DAM Acct. No. 6036 Page 2 of 6
 Subject WOZESTER MASS AREA Comptd. By MJ BARNES/LB Date 11/14/78
 Detail FISHERVILLE POND DAM Ch'd. By MLL/MBG Date 12/28/78

II DAM DISCHARGE RATINGS

A) - SPILLWAY [Ref. "Hydraulic Tables" - William E. Hagen]

Narrow Crest ~ Sharp Crest - use Tables up to $H = 6'$

For $H > 6'$: $g = 51.64 \text{ cfs/ft for } H = 6'$; $K = 3.5 = \frac{51.64}{(6)^{1.5}}$

$$\therefore g = 3.5 H^{1.5}$$

POND EL.	290	291	292	293	294	295	296	297	298
Q_R (cfs)	670	1090	3500	5460	7740	10300	13000	15800	18900

POND EL.	299	300	301	302	303	304	305
Q_R (cfs)	22100	25500	29100	32800	36700	40700	44800

B) FLOW OVER CREST OF DAM

BROAD CREST - 600' long - However due to bldg restriction use $L = 300'$

$$g_c = 2.55 H^{3/2}$$

$$Q_c = 2.55(300) H^{3/2} = 765 H^{3/2} \quad \text{CREST @ EL 296} \pm$$

Pond El	297	298	299	300	301	302	303	304	305
Q_c (cfs)	760	2160	4600	6100	8500	11200	14200	17300	20700

Add Q_R	15800	18900	2100	25500	29100	32800	36700	40700	44800
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Total	16600	21100	26100	31600	37600	44000	50900	58000	65500
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Project Worcester County, Mass. Act No. 170-67 Page 1 of 5
 Subject Worcester County, Mass. Comprd. By LEB Date 11/13/78
 Detail FISHERVILLE POND DAM Ckd. By MLL/MBG Date 12/28/78

I Test Flood, 100 year storm & Storage Functions

1- Total Drainage Area - 134 mi²

2- Pond(s) Area: 4.6 mi²
 Swamp(s) Area: 2.3 (Estimated)
 Total Area Ponds & Swamp(s): 6.9 "

$$\% \text{ Ponds \& Swamps} = \frac{6.9}{134} = 5.1\%$$

$$3- \frac{1370' - 290'}{22.2 \text{ mi}} = 0.9\% \quad \left. \vphantom{\frac{1370' - 290'}{22.2 \text{ mi}}} \right\} \text{ Say Ave Slope} = 0.9\%$$

4- Using C. of E. Curves for Peak Flow Rates $\frac{1}{2}$ above guide, values the Peak Flow Rate was estimated to be somewhat higher than "Flat & Coastal" and taken at 450 c.f.s./mi.
 Size Class: Intermediate; Hazard Pot.: High; Spill. Des. Flood: Full PMF
 Use: Test Flood = Full P.M.F.

$$5- \text{Test Flood Inflow} = (450) 134 = 60000 \text{ c.f.s.}$$

6- Pond Storage

The pond area is 0.29 sq. mi. at elev. 290.
 Based on a const. area, storage increases at 185 ac. feet per foot of depth increase.
 Heavy siltation has minimized pond storage at levels below the spillway crest.
 Storage above spillway crest at elev. 299 is 1850 ac. feet.

7- Storage Functions are based on $Q_{out} = Q_{in} \left[1 - \frac{S_{out}}{R} \right]$

S_{out} = Storage Vol. in Reservoir related to final Q_{out} in terms of inches of rain over the drainage area.

$$S(\text{in Inches}) = 12 D \left(\frac{0.29}{134} \right) = .026 D; R = \text{hr rain depth}$$

D = Storage Depth (above spillway) on reservoir, in feet

8- Storage Functions: (F_{TF}) ; $D = 0$ @ Pond El. 289

$$F_{TF} = 60000 - 3158 S = 60000 - 82.1 D$$

Project NAT REVIEW OF NON FED DAMS Acct. No. 6036 Page 5 of 6
 Subject WORCESTER MASS AREA Comptd. By MJBARNES/LB Date 11/17/78
 Detail FISHERVILLE POND DAM Ck'd. By MLL/MBG Date 12/28/78

(V)

RESULTS

PEAK OUTFLOW FROM TEST FLOOD IS 58300 CFS
 WITH POND ELEV. 304

$$\text{MAX FLOW OVER CREST} = 2.55 (304.2 - 286)^{1.5} = 59.9 \text{ cfs/ft}$$

$$Y_c = \left[\frac{(59.9)^2}{32.2} \right]^{1/3} = 4.8 \text{ FT}$$

$$V_c = 59.9 / 4.8 = 12.5 \text{ FPS}$$

(VI)

DAM FAILURE

POND ELEV = 296
 TOE EL = 286

$$Y_o = 10'$$

DAM LENGTH SUBJECT TO BREACHING = 322' (Mid Ht. of Dam)

$$W_o = 40\% (322) = 129'$$

$$Q_o = 1.68 W_o / Y_o^{1.5} = 1.68 (129) (10)^{1.5} = 7,000 \text{ CFS}$$

Add Q_{spillway}
 TOTAL

$$\frac{13,000}{20,000}$$

STORAGE VOLUME RELIEF

$$\text{STORAGE ABOVE EL 290} = (296 - 290) 185 = 1,110 \text{ AC-FT}$$

$$\text{STORAGE BELOW EL 290} = \frac{1}{2} (290 - 286) (88) = 250 \text{ AC-FT}$$

$$\text{TOTAL STORAGE} = 1,360 \text{ AC-FT}$$

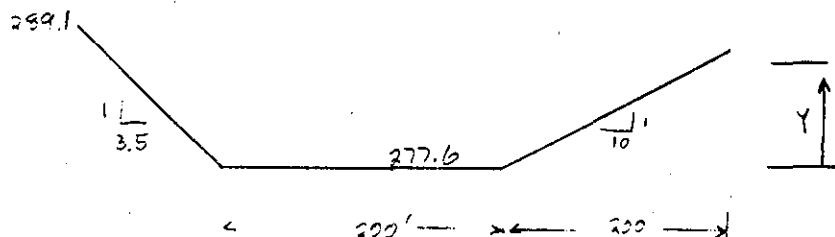
TIME TO DEAN

$$\frac{1360 (1360)}{3600 (1/2) 20000} = 1.6 \text{ HRS (omits continuing inflow to pond)}$$

Project NAT REVIEW OF NOW FEE DAMS Acct No 6036 Page 6 of 6
 Subject WORCESTER MASS AREA Comptd By MTBARI/ES/LB Date 11/17/78
 Detail FISHKILL POND DAM Ckd By MLL/MBG Date 12/24/78



DAM FAILURE (CONT.)



Dike EL @ 289.1

$$Q = \frac{1.48 R^{2/3} S^{1/2} A}{n}$$

$$= 2.648 R^{2/3} A$$

$$A = 200y + 6.75y^2$$

$$P = 200 + 13.7y$$

RIVER INV. @ DAM = 277.64
 @ BRIDGE = 271.86

$$S = \frac{277.64 - 271.86}{700} = 0.0082 \text{ ft/ft}$$

$$n = 0.06$$

Y	A	R	Q (CFS)	V (FPS)	RIVER ELEV. (@ West End Spill.)
2	427	1.87	1457		279.6
3	661	2.74	2908		280.6
4	908	3.57	4768		281.6
5	1169	4.35	7014	6.0	282.6
6	1443	5.15	9674		283.6
7	1731	5.85	12630	7.3	284.6
8	2032	6.60	16072	7.9	285.6
9	2347	7.29	19851	8.5	286.6
10	2675				
12	3372	9.25	33411	9.9	289.6
14	4123				
16	4928	11.76	57275	11.6	293.6
17	5351	12.36	64307	12.0	294.6

Spill Cap. $y \approx 7.1'$, $V \approx 7.4 \text{ fps}$

Dam Failure Total - $y \approx 9'$, $V \approx 8.5 \text{ fps}$

T.F. outflow - $y = 16.3' \pm$, $V = 11.7 \text{ fps} \pm$

BRIDGE IS 700' DOWNSTREAM WITH INV EL = 285.33

FIRST HOUSE IS 600' DOWNSTREAM AT EL 290.2

APPENDIX E

INFORMATION AS CONTAINED IN THE
NATIONAL INVENTORY OF DAMS

FISHERVILLE POND DAM

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) COUNTY	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR. DIST.	(7) NAME	(8) LATITUDE (NORTH)	(9) LONGITUDE (WEST)	(10) REPORT DATE DAY MO YR
MA	577	AND	MA	027	05	FISHERVILLE POND DAM	4210.7	7141.3	24NOV78

(11) POPULAR NAME	(12) NAME OF IMPOUNDMENT
	FISHERVILLE POND

(13) REGION	(14) BASIN	(15) RIVER OR STREAM	(16) NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	(17) DIST. FROM DAM (MI)	(18) POPULATION
01	06	BLACKSTONE RIVER	GRAFTON	0	10650

(19) TYPE OF DAM	(20) YEAR COMPLETED	(21) PURPOSES	(22) STRUCTURAL HEIGHT (FT.)	(23) HYDRAULIC HEIGHT (FT.)	(24) IMPOUNDING CAPACITIES (ACRE-FT.)		(25) DIST. DOWN	(26) FED	(27) W	(28) PRV/FED	(29) SCS	(30) A	(31) VER/DATE
WEIRACTPG	1882	S	20	20	1800	500	NED	N	N	N	N	N	110EC78

(32) REMARKS

(33) D/S HAS	(34) SPILLWAY		(35) MAXIMUM DISCHARGE (FT.)	(36) VOLUME OF DAM (CY)	(37) POWER CAPACITY		(38) NAVIGATION LOCKS												
	CHS. LENGTH	TYPE			WIDTH (FT.)	INSTALLED (MW)	PROPOSED (MW)	NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)					
1	960	U	200	1300	10000														

(39) OWNER	(40) ENGINEERING BY	(41) CONSTRUCTION BY
KALTSAS BROTHERS INC.	S.C. HEALD	UNKNOWN

(42) REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

(43) INSPECTION BY	(44) INSPECTION DATE DAY MO YR	(45) AUTHORITY FOR INSPECTION
METCALF AND EDDY INC.	20SEP78	PUBLIC LAW 92-367

(46) REMARKS

END

FILMED

8-85

DTIC